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FORM PTO-1390 (Modified) (REV 11-98) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	
L9289.01125	
U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR	
New Application	

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/JP00/05597	August 22, 2000	August 27, 1999

TITLE OF INVENTION
OFDM COMMUNICATION APPARATUS

APPLICANT(S) FOR DO/EO/US
Hiroaki SUDO

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☐ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

The PTO did not receive the following listed item(s) _____

Claim for Priority with PCT/IB/304
PCT/IB/308
PCT/RO/101

PCTUS1/REV03

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
New Application 09/806412	PCT/JP00/05597	L9289.01125

21. The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS PTO USE ONLY
☐	Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO and International Search Report not prepared by the EPO or JPO	**$1,000.00**
☒	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but Internation Search Report prepared by the EPO or JPO	**$860.00**
☐	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO	**$710.00**
☐	International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4)	**$690.00**
☐	International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4)	**$100.00**

ENTER APPROPRIATE BASIC FEE AMOUNT =	**$860.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$0.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	5 - 20 =	0	x $18.00	**$0.00**	
Independent claims	4 - 3 =	1	x $80.00	**$80.00**	
Multiple Dependent Claims **(check if applicable).**			☐	**$0.00**	
TOTAL OF ABOVE CALCULATIONS =				**$940.00**	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) **(check if applicable).**			☐	**$0.00**	
SUBTOTAL =				**$940.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				**$0.00**	
TOTAL NATIONAL FEE =				**$940.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).**			☒	**$40.00**	
TOTAL FEES ENCLOSED =				**$980.00**	
				Amount to be: refunded	$
				charged	$

☒ A check in the amount of **$980.00** to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. in the amount of to cover the above fees.
A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **19-4375** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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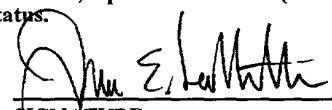


SIGNATURE

James E. Ledbetter
NAME

28,732
REGISTRATION NUMBER

March 30, 2001
DATE

DESCRIPTION

OFDM COMMUNICATION APPARATUS

Technical Field

The present invention relates to an OFDM (Orthogonal Frequency Division Multiplexing) communication apparatus that performs transmission diversity, and particularly to an OFDM communication apparatus that performs retransmission control.

Background Art

The conventional OFDM communication apparatus that performs transmission diversity will be explained with reference to FIG. 1. FIG. 1 is a block diagram illustrating the configuration of a base station apparatus comprising the conventional OFDM communication apparatus that performs transmission diversity. It is noted that FIG. 1 shows the configuration on the assumption that the number of branches is 2.

Regarding retransmission control at the base station apparatus having the conventional OFDM communication apparatus that performs transmission diversity, the explanation as an example is given of the case in which this base station apparatus performs radio communication with a mobile station apparatus having the configuration as illustrated in FIG. 2. FIG. 2 is a block diagram illustrating the configuration of the mobile station

apparatus that performs radio communication with the base station apparatus having the conventional OFDM communication apparatus that performs transmission diversity. The following will explain the case in which the base station apparatus transmits a signal to the mobile station and an error is present in the signal transmitted by the base station apparatus, in which case the base station retransmits the error signal to the mobile station.

The signal transmitted by the mobile station apparatus illustrated in FIG. 2 is received by the base station apparatus illustrated in FIG.1. Referring to FIG. 1, in the receiving system, the signals (received signals) through an antenna 16 and an antenna 17, namely the received signal from a branch 1 and the received signal from branch 2 are subjected to FFT (Fast-Fourier-transform) processing by an FFT section 18 and an FFT section 19. Signals arranged to the respective subcarriers at branches 1 and 2 are outputted to a reception diversity section 20 from an FFT section 18 and an FFT section 19.

The reception diversity section 20 provides reception diversity processing to the signals arranged to the respective subcarriers at the branches 1 and 2. Regarding this reception diversity processing, the reception diversity section 20 selects a received signal with a high reception level at the branch for each signal of each subcarrier or combines received signals at the respective branches.

A demodulating/error correcting section 21 provides demodulation processing and error correction processing to the signal subjected to reception diversity processing. The signal subjected to demodulation processing and error correction processing is sent to a retransmission control section 11. In the case where no error is present in the signal subjected to demodulation processing and error correction processing at the retransmission control section 11, this signal is outputted as a received signal.

On other hand, in the transmitting system, a transmitting signal is stored in the retransmission control section 11. This transmitting signal is a signal in packet unit. The transmitting signal stored is transmitted to a coding/modulating section 12 from the retransmission control section 11 in accordance with transmission timing.

The coding/modulating section 12 provides code processing and modulation processing to the signal transmitted from the retransmission control section 11. The signal subjected to code processing and modulation processing is sent to a transmitting subcarrier selecting section 13.

By the way, the base station apparatus can normally perform the transmission diversity when performing TDD communication with the mobile station apparatus. Namely, the base station apparatus selects a signal to be transmitted for each branch based on the selection result

done by the reception diversity section 20 from among the signals arranged to the respective subcarriers.

However, in the case where the time interval between a reverse link and a forward link is long or the transmitting signal is concurrently received by a plurality of users (mobile stations) as in multicast communications, it is difficult for the base station apparatus to perform the above-mentioned transmission diversity.

For this reason, in the aforementioned case, the base station apparatus fixedly transmits the signals arranged to the respective subcarriers from any one of branches. Namely, in the aforementioned case, the following processing is provided at the transmitting subcarrier selecting section 13.

More specifically, the transmitting subcarrier selecting section 13 selects subcarriers to be fixedly transmitted for each branch. For example, as subcarriers to be transmitted with respect to the branch 1, odd-numbered subcarriers are fixedly selected as illustrated in FIG. 3A. Moreover, as subcarriers to be transmitted with respect to the branch 2, even-numbered subcarriers are fixedly selected as illustrated in FIG. 3B.

Thereafter, among the signals transmitted from coding/modulating section 12, only the signal to be arranged to the subcarriers to be transmitted with respect to the branch 1 is outputted to an IFFT section 14 from

the transmitting subcarrier selecting section 13. Moreover, among the signals transmitted from coding/modulating section 12, only the signal to be arranged to the subcarriers to be transmitted with respect to the branch 2 is outputted to an IFFT section 15 from the transmitting subcarrier selecting section 13.

The IFFT section 14 and IFFT section 15 provide IFFT (Inverse-Fast-Fourier-Transform) processing to the signals from the transmitting subcarrier selecting section 13 respectively. The signals subjected to IFFT processing by the IFFT section 14 and IFFT section 15 are transmitted to the mobile station apparatus via the antenna 16 and antenna 17 respectively.

In a mobile station apparatus (FIG. 2), a signal received from an antenna 34 is subjected to FFT processing by an FFT section 34. A demodulating/error correcting section 36 provides demodulation processing and error correction processing to the signal subjected to FFT processing, and the resultant is outputted to a retransmission control section 31.

In the case where no error is present in the signal subjected to demodulation processing and error correction processing at the retransmission control section 31, the signal is outputted as a received signal. Conversely, in the case where an error is present in the signal subjected to demodulation processing and error correction processing, this signal is stored onto a given memory.

In the case where an error is present in the signal subjected to demodulation processing and error correction processing, transmission including a packet that requests the base station apparatus of the retransmission of this signal is subjected to code processing/modulation processing by a coding/modulating section 32, and is further subjected to IFFT processing by an IFFT section33, and then the resultant is transmitted to the base station apparatus via the antenna 34.

Thereafter, in the base station apparatus (FIG. 1), a packet subjected to a request for retransmission by the mobile station apparatus is transmitted to the coding/modulating section 12 at the retransmission control section 11 in accordance with retransmission timing. This packet is subjected to the same processing as mentioned above, and is retransmitted to the mobile station apparatus via the antenna 16 and antenna 17.

Thus, the signal having an error in the mobile station apparatus is retransmitted to the base station apparatus.

However, in the conventional OFDM communication apparatus that performs the transmission diversity, there is a problem set forth below.

More specifically, in the aforementioned mobile station apparatus, circumstances may be generated where poor-quality signals are intensively input for a certain specific time as signals that will be subjected to error correction processing.

In order to explain the above circumstances, FIG. 4 is used. FIG. 4 is a schematic view illustrating one example of arrangements of subcarriers in connection with the signal received by the mobile station apparatus that performs radio communication with the base station apparatus having the conventional OFDM transmission diversity. It is noted that the transmission subcarrier selecting section 13 of the base station apparatus performs the selection of subcarriers to be transmitted as mentioned above.

When the signals where subcarriers are arranged as illustrated in FIG. 4 is received by the mobile station apparatus (FIG. 2), the signals, which are outputted from the FFT section 25, are those extracted from the respective subcarriers on the time series in order of subcarriers 1, 2, 3, 4 … As is obvious from FIG. 4, the quality of the signals arranged in the respective subcarriers 1 to 4 becomes worse.

As a result, regarding the signals inputted to the modulating/correcting section 36, since poor-quality signals are intensively input for a certain specific time, the effect obtained from error correction processing is reduced and the signals having errors are frequently outputted to the retransmission control section 31. As a result, the base station apparatus retransmits the same packet.

Moreover, in the case where the fluctuation in the

channel (transmission path) state is slower than the time interval at which the base station apparatus transmits the same packet, the channel state in which the same packet is first transmitted and the channel state in which the same packet is retransmitted are substantially the same as each other.

In this case, at the time of receiving the signal including the retransmitted packet by the mobile station apparatus, the state of arrangement of subcarriers in the received signal is substantially the same as the state illustrated in FIG. 4. For this reason, regarding the packet retransmitted by the base station apparatus, possibility that an error will occur is extremely increased at the mobile station apparatus, and this causes a problem in which an error occurs continuously in the packet. Accordingly, it takes much time till the mobile station apparatus receives a certain specific packet without failure that is transmitted by the base station apparatus.

Disclosure of Invention

It is an object of the present invention is to provide an OFDM communication apparatus that performs transmission diversity capable of reducing a probability that errors continuously occur in the same transmitting signal.

The above object can be attained by changing subcarriers to be transmitted for each branch in accordance

with the number of retransmissions of transmitting signal.

Brief Description of Drawings

FIG. 1 is a block diagram illustrating the configuration of a base station apparatus having a conventional OFDM communication apparatus that performs transmission diversity;

FIG. 2 is a block diagram illustrating the configuration of a mobile station apparatus that performs radio communication with the conventional base station apparatus of FIG. 1;

FIG. 3A is a schematic view illustrating one example of arrangement of subcarriers selected with respect to a branch 1 at the base station apparatus having the OFDM communication apparatus that performs transmission diversity;

FIG. 3B is a schematic view illustrating one example of arrangement of subcarriers selected with respect to a branch 2 at the base station apparatus having the OFDM communication apparatus that performs transmission diversity;

FIG. 4 is a schematic view illustrating one example of arrangement of subcarriers with respect to a signal received by the mobile station apparatus that performs radio communication with the conventional base station apparatus of FIG. 1;

FIG. 5 is a block diagram illustrating the

configuration of a base station apparatus having an OFDM communication apparatus that performs transmission diversity according to an embodiment of the present invention;

FIG. 6A is a schematic view illustrating one example of arrangement of subcarriers selected at a retransmitting time with respect to a branch 1 at the base station apparatus having the OFDM communication apparatus that performs transmission diversity according to the above embodiment;

FIG. 6B is a schematic view illustrating one example of arrangement of subcarriers selected at a retransmitting time with respect to a branch 2 at the base station apparatus having the OFDM communication apparatus that performs transmission diversity according to the above embodiment; and

FIG. 7 is a schematic view illustrating one example of arrangement of subcarriers with respect to a signal received by the mobile station apparatus that performs radio communication with the base station apparatus having the OFDM communication apparatus that performs transmission diversity according to the above embodiment.

Best Mode for Carrying Out the Invention

The best mode for carrying out the present invention will be specifically explained with

reference to the drawings. Regarding an OFDM communication apparatus that performs transmission diversity according to the present invention, the embodiment set forth below gives an explanation of the case as an example in which this OFDM communication apparatus is mounted on the base station apparatus. However, the OFDM communication apparatus that performs transmission diversity according to the present invention is mountable on a communication terminal apparatus.

(Embodiment)

FIG. 5 is a block diagram illustrating the configuration of a base station apparatus having an OFDM communication apparatus that performs transmission diversity according to an embodiment of the present invention. Though FIG. 5 shows the case in which the number of branches is 2, the number of branches is not limited.

Regarding the retransmission control using the base station apparatus having the OFDM communication apparatus that performs transmission diversity according to an embodiment of the present invention (hereinafter simply referred to as "base station apparatus"), an explanation is given of the case as an example in which the base station apparatus performs radio communication with the mobile station apparatus. The following will explain

the case in which the base station apparatus transmits a signal to the mobile station and an error is present in the signal transmitted by the base station apparatus, in which case the base station transmits again (retransmits) the error signal to the mobile station. It is noted that the configuration illustrated in FIG. 2 makes the mobile station apparatus implementable.

The signal transmitted by the mobile station apparatus illustrated in FIG. 2 is received by the base station apparatus illustrated in FIG.5. Referring to FIG. 5, in the receiving system, the signals (received signals) through an antenna 109 and an antenna 110, namely the received signal from a branch 1 and the received signal from branch 2 are subjected to FFT processing by an FFT section 111 and an FFT section 112. Signals arranged to the respective subcarriers at branches 1 and 2 are outputted to a reception diversity section 113 from FFT section 111 and FFT section 113.

The reception diversity section 113 provides reception diversity processing to the signals arranged to the respective subcarriers at the branches 1 and 2. Regarding this reception diversity processing, the reception diversity section 113 selects a received signal with a high reception level at the branch for each signal of each subcarrier or combines received signals at the respective branches.

A demodulating/error correcting section 114

provides demodulation processing and error correction processing to the signal subjected to reception diversity processing. The signal subjected to demodulation processing and error correction processing is sent to a retransmission control section 101. In the case where no error is present in the signal subjected to demodulation processing and error correction processing at the retransmission control section 101, this signal is outputted as a received signal.

On other hand, in the transmitting system, a transmitting signal is stored in the retransmission control section 101. This transmitting signal is a signal in packet unit. The transmitting signal stored or the transmitting signal of packet unit subjected to a request for retransmission by the mobile station apparatus is transmitted to a coding/modulating section 102 from the retransmission control section 101 in accordance with transmission timing or retransmission timing.

The coding/modulating section 102 provides code processing and modulation processing to the signal transmitted from the retransmission control section 101. The signal subjected to code processing and modulation processing is sent to a first transmitting subcarrier selecting section 103 and a second transmitting subcarrier selecting section 104.

The first transmitting subcarrier selecting section 103 selects subcarriers to be fixedly transmitted for each

branch. For example, as subcarriers to be transmitted with respect to the branch 1, odd-numbered subcarriers are fixedly selected as illustrated in FIG. 3A. Moreover, as subcarriers to be transmitted with respect to the branch 2, even-numbered subcarriers are fixedly selected as illustrated in FIG. 3B.

Thereafter, among the signals transmitted from coding/modulating section 102, only the signal to be arranged to the subcarriers to be transmitted with respect to the branch 1 is outputted to a selector 105 from the first transmitting subcarrier selecting section 103. Moreover, among the signals transmitted from coding/modulating section 102, only the signal to be arranged to the subcarriers to be transmitted with respect to the branch 2 is outputted to a selector 106 from the first transmitting subcarrier selecting section 103.

The second transmitting subcarrier selecting section 104 selects subcarriers to be fixedly transmitted for each branch. However, the subcarriers selected for each branch by the second transmitting subcarrier selecting section 104 are different from those selected for each branch by the first transmitting subcarrier selecting section 103.

For example, as subcarriers to be transmitted with respect to the branch 1, odd-numbered subcarriers are fixedly selected as illustrated in FIG. 6A. Moreover, as subcarriers to be transmitted with respect to the branch

2, even-numbered subcarriers are fixedly selected as illustrated in FIG. 6B.

Thereafter, among the signals transmitted from coding/modulating section 102, only the signal to be arranged to the subcarriers to be transmitted with respect to the branch 1 is outputted to the selector 105 from the second transmitting subcarrier selecting section 104. Moreover, among the signals transmitted from coding/modulating section 102, only the signal to be arranged to the subcarriers to be transmitted with respect to the branch 2 is outputted to the selector 106 from the second transmitting subcarrier selecting section 104.

At the selector 105 and selector 106, the signal outputted from either the first transmitting subcarrier selecting section 103 or the second transmitting subcarrier selecting section 104 is outputted to the IFFT section in accordance with control by the retransmission control section 101.

More specifically, in accordance with the number of retransmissions of transmitting signal (packet) which will be transmitted from the retransmission control section 101, namely, whether the transmitting signal which will be transmitted from the retransmission control section 101 is one that will be transmitted for the first time or one that will be retransmitted, the retransmission control section 101 outputs a control signal, which indicates which signal from the first transmitting

subcarrier selecting section 103 or the second transmitting subcarrier selecting section 104 should be outputted to the IFFT section, to the selector 105 and selector 106, respectively.

According to this embodiment, the control signal outputted from the retransmission control section 101 is set so that;

from selectors 105 and 106 to the IFFT section, the signal from the first transmitting subcarrier selecting section 103 is outputted, in the case where the transmitting signal which will be transmitted from the retransmission control section 101 is one that will be transmitted for the first time,

from selectors 105 and 106 to the IFFT section, the signal from the second transmitting subcarrier selecting section 104 is outputted, in the case where the transmitting signal which will be transmitted from the transmission control section 101 is one that will be retransmitted.

In accordance with the aforementioned control signal, the signal to be arranged to the subcarriers to be transmitted with respect to the branch 1 is outputted to an IFFT section 107 from the selector 105. Also, the signal to be arranged to the subcarriers to be transmitted with respect to the branch 2 is outputted to an IFFT section 108 from the selector 106.

The signals outputted from the selector 105 and

selector 106 are subjected to IFFT processing by the IFFT section 107 and IFFT section 108, thereafter they are transmitted to the mobile station apparatus via the antenna 109 and antenna 110, respectively.

Herein, the following will explain how the state of the signal received by the mobile station apparatus is changed at the base station apparatus when the subcarriers to be transmitted for each branch are changed at the first transmitting time of a certain transmitting signal and the retransmitting time.

In the case where a certain specific packet is received for the first time by the mobile station apparatus, when the channel state is as illustrated in FIG. 4, the signals, which are subjected to FFT processing at the mobile station apparatus, are those extracted from the respective subcarriers on the time series in order of subcarriers 1, 2, 3, 4 … Regarding the signals thus extracted, the quality of the signals arranged in the respective subcarriers 1 to 4 becomes worse, resulting in signals where errors intensively occur for a certain specific time.

On the other hand, at the time of retransmitting the above specific packet, the base station apparatus makes the subcarriers to be transmitted for each branch different from those at the first transmitting time with respect to the above specific packet as mentioned above. For this reason, the channel used when the base station apparatus

transmits the specific packet for the first time and the channel used when retransmitting it are independent of each other, that is, different from each other.

For this reason, in the case where the specific packet is retransmitted by the mobile station apparatus, there is a high possibility that the channel condition will be different from the channel state when the specific packet is received for the first time as illustrated in FIG. 7. In this case, as is obvious from FIG. 7, the signals subjected to FFT processing at the mobile station apparatus results in a signal having a low possibility that errors will intensively occur for a certain specific time in low-quality signals.

Accordingly, even in the case where the channel used when the base station apparatus transmits the specific packet for the first time and the channel used when retransmitting it are little changed, possibility that an error will occur in the packet retransmitted by the base station is greatly reduced. Namely, in the above case, it is possible to prevent the problem in which errors continuously occur in the certain specific packet.

Thus, according to this embodiment, the subcarriers to be transmitted for each branch are changed in the case of transmitting the certain specific packet for the first time from the base station apparatus and the case of retransmitting it, so the signals which are arranged to the subcarriers and transmitted from each branch, are different

from each other in each case. This makes the channel states in the respective case independent of each other, so that probability that errors will continuously occur in the same packet can be reduced. Accordingly, in the case where an error occurs in a certain specific packet, it is possible to reduce time required for receiving the specific packet without any errors.

The above embodiment has explained the case in which two kinds of combinations to select subcarriers to be transmitted. However, the present invention is not limited to the above case, and the present invention is applicable to a case in which the number of combinations to select subcarriers to be transmitted is increased. The present invention is also applicable to a case in which combinations to select subcarriers to be transmitted is arbitrarily set.

Moreover, the present invention is also applicable to a case in which combinations to select subcarriers to be transmitted is independently set for each unit frame. This makes it possible to change the channel state during the reception of a certain packet and to reduce the possibility that errors will continuously occur in the same packet without fail.

The above embodiment has explained the case in which the subcarriers to be transmitted for each branch are changed in accordance with the number of retransmissions of a certain packet. However, the present invention is not limited to this, and it is applicable to a case in which

the combinations of subcarriers to be transmitted for each branch are changed in accordance with various conditions of such as a channel quality, and the like.

Furthermore, the OFDM communication apparatus that performs transmission diversity according to the embodiment of the present invention is mountable on a communication terminal apparatus and a base station apparatus in a digital mobile communication system.

① An OFDM communication apparatus of the present invention comprises subcarrier selecting means for selecting subcarriers to be transmitted from a given branch in accordance with the number of retransmissions of transmitting signals; and transmitting means for arranging signals transmitting from the given branch among the transmitting signals to the selected subcarriers to perform TIFFT processing.

According to the above configuration, the subcarriers to be transmitted for each branch are changed in the case of transmitting the certain transmitting signal for the first time and the case of retransmitting it. For this reason, in the case where an error occurs in a certain specific transmitting signal, it is possible to reduce time required for receiving the specific transmitting signal without any errors.

② In the OFDM communication apparatus of the present invention, the subcarrier selecting means

selects unique subcarriers for each unit frame.

According to the above configuration, since the channel state can be changed while a certain transmitting signal is received, it is possible to further reduce the probability that errors will continuously occur in the same transmitting signal without fail.

③A communication terminal apparatus of the present invention has any one of the above-mentioned OFDM communication apparatuses.

④A base station apparatus of the present invention has any one of the above-mentioned OFDM communication apparatuses.

According to the above configuration, there can be provided the communication terminal apparatus and the base station apparatus that is capable of reducing time required for receiving a specific transmitting signal without any errors in the case where an error occurs in the certain specific transmitting signal.

⑤ An OFDM communication method of the present invention comprises the subcarrier selecting step of selecting subcarriers to be transmitted from a given branch in accordance with the number of retransmissions of transmitting signals; and the transmitting step of arranging signals transmitting from the given branch among the transmitting signals

to the selected subcarriers to perform TIFFT processing.

According to the above method, the subcarriers to be transmitted for each branch are changed in the case of transmitting the certain transmitting signal for the first time and the case of retransmitting it. For this reason, in the case where an error occurs in a certain specific transmitting signal, it is possible to reduce time required for receiving the specific transmitting signal without any errors.

As explained above, according to the present invention, since the subcarriers to be transmitted are changed for each branch in accordance with the number of retransmissions of transmitting signals, it is possible to provide the OFDM communication apparatus that performs transmission diversity capable of reducing probability that errors continuously occur in the same transmitting signal.

This application is based on the Japanese Patent Application No. HEI 11-240878 filed on August 27,1999, entire content of which is expressly incorporated by reference herein.

Industrial Applicability

The present invention is suitable for use in

the field of the OFDM communication apparatus that performs retransmission control.

CLAIMS

1. An OFDM communication apparatus comprising:

subcarrier selecting means for selecting subcarriers to be transmitted from a branch in accordance with the number of retransmissions of transmitting signals; and

transmitting means for arranging signals to be transmitted from the branch among said transmitting signals to said selected subcarriers to perform IFFT processing.

2. The OFDM communication apparatus according to claim 1, wherein said subcarrier selecting means selects unique subcarriers for each unit frame.

3. A communication terminal apparatus having an OFDM communication apparatus, wherein said OFDM communication apparatus comprising:

subcarrier selecting means for selecting subcarriers to be transmitted from a branch in accordance with the number of retransmissions of transmitting signals; and

transmitting means for arranging signals to be transmitted from the branch among said transmitting signals to said selected subcarriers to perform IFFT processing.

4. A base station apparatus having an OFDM communication apparatus, wherein said OFDM communication apparatus comprising:

subcarrier selecting means for selecting subcarriers to be transmitted from a branch in accordance with the number of retransmissions of transmitting signals; and

transmitting means for arranging signals to be transmitted from the branch among said transmitting signals to said selected subcarriers to perform IFFT processing.

5. An OFDM communication method comprising:

subcarrier selecting step for selecting subcarriers to be transmitted from a branch in accordance with the number of retransmissions of transmitting signals; and

transmitting step for arranging signals to be transmitted from the branch among said transmitting signals to said selected subcarriers to perform IFFT processing.

ABSTRACT

An OFDM communication apparatus comprises subcarrier selecting means for selecting subcarriers to be transmitted for each branch in accordance with the number of retransmissions of transmitting signals and transmitting means for providing TIFFT processing to transmitting signals arranged in said subcarriers for each branch to transmit the resultant.

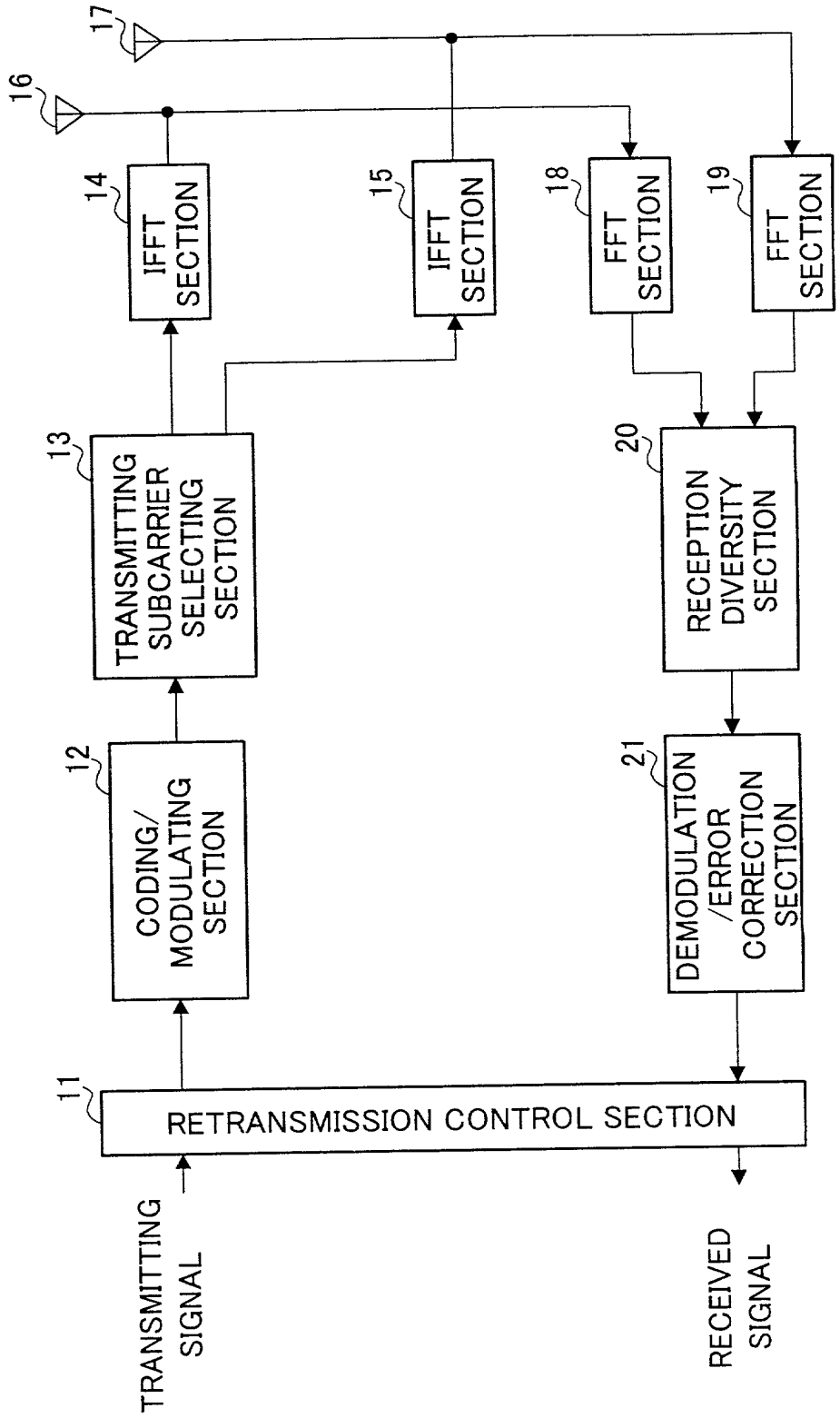

17
16
14
IFFT SECTION
15
IFFT SECTION
18
FFT SECTION
19
FFT SECTION
13
TRANSMITTING SUBCARRIER SELECTING SECTION
20
RECEPTION DIVERSITY SECTION
12
CODING/ MODULATING SECTION
21
DEMODULATION /ERROR CORRECTION SECTION
11
RETRANSMISSION CONTROL SECTION
TRANSMITTING SIGNAL
RECEIVED SIGNAL

FIG.1

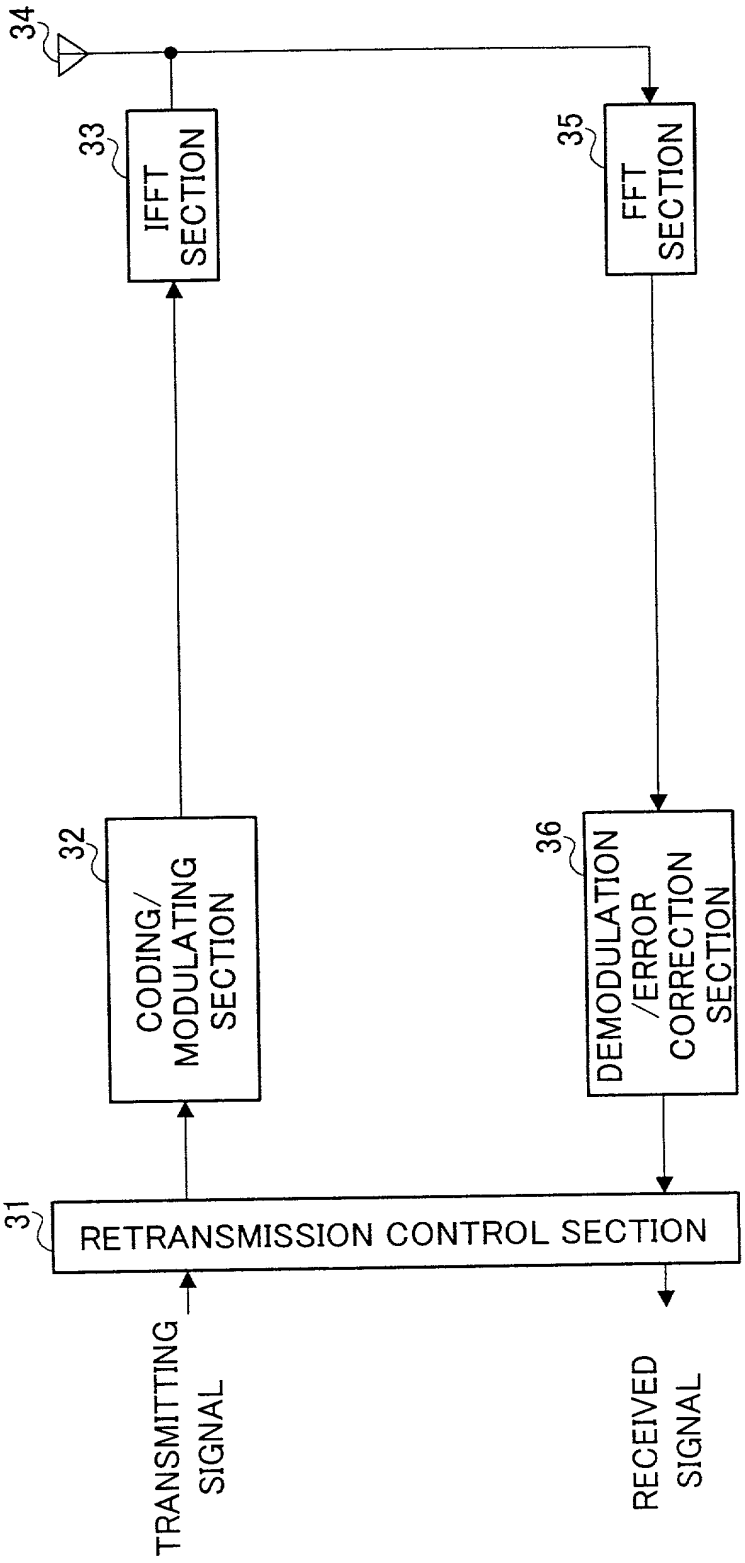

34
33
IFFT SECTION
35
FFT SECTION
32
CODING/ MODULATING SECTION
36
DEMODULATION /ERROR CORRECTION SECTION
31
RETRANSMISSION CONTROL SECTION
TRANSMITTING SIGNAL
RECEIVED SIGNAL

FIG.2

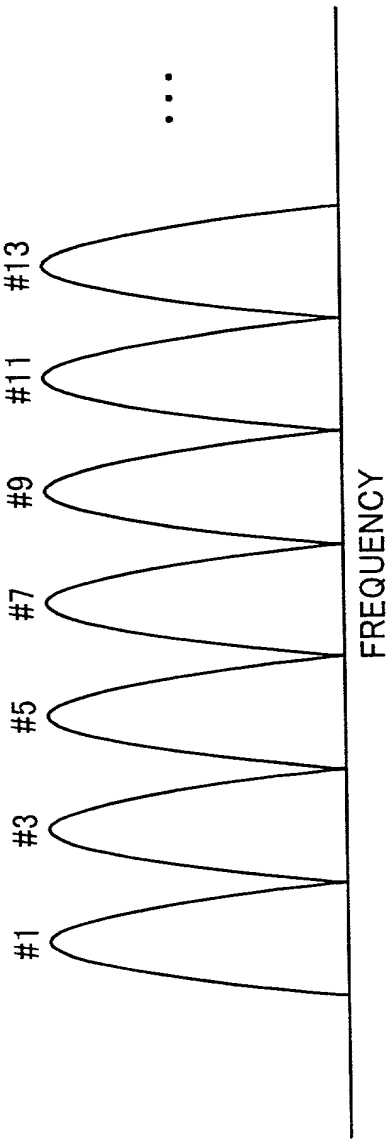


FIG.3 A

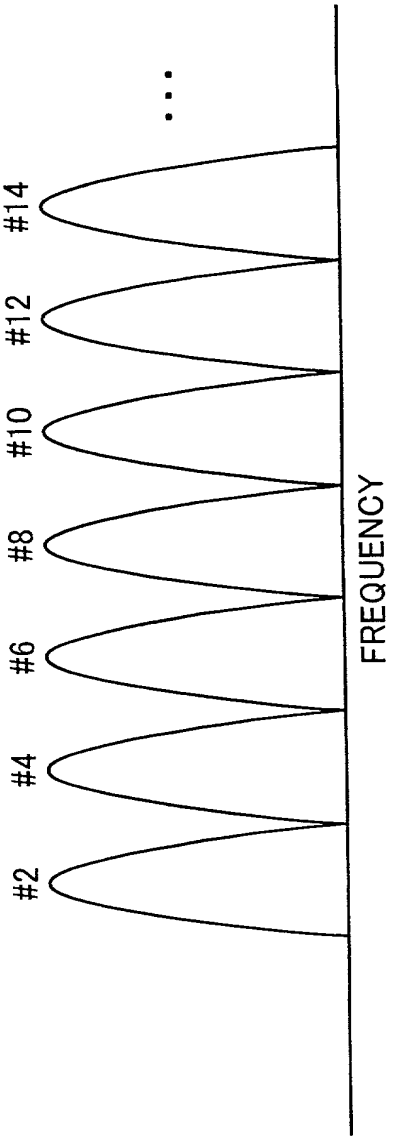


FIG.3 B

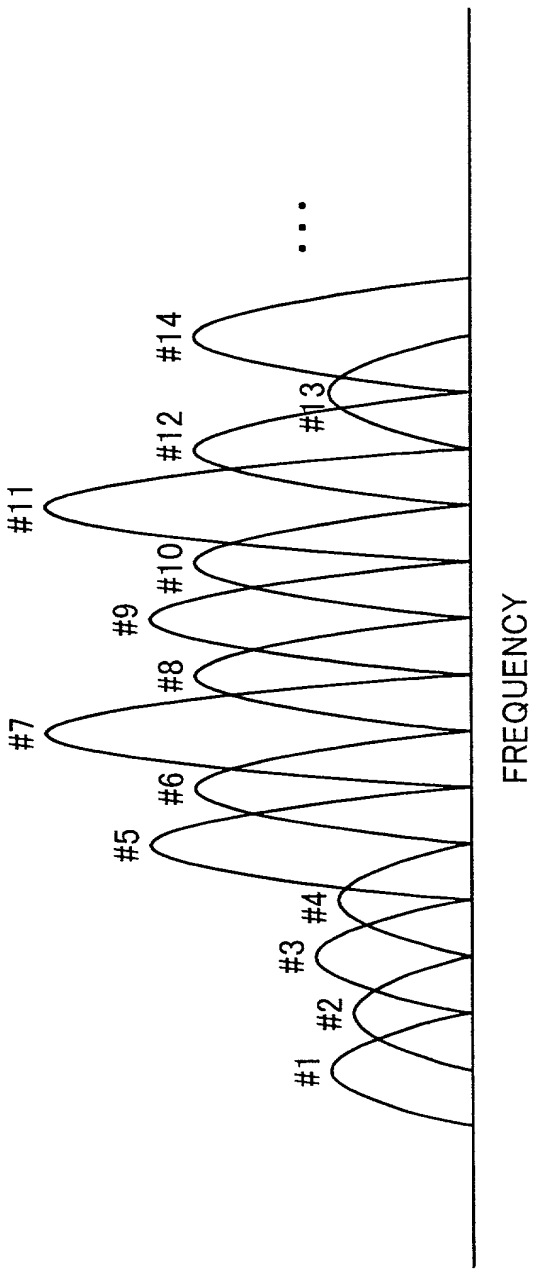
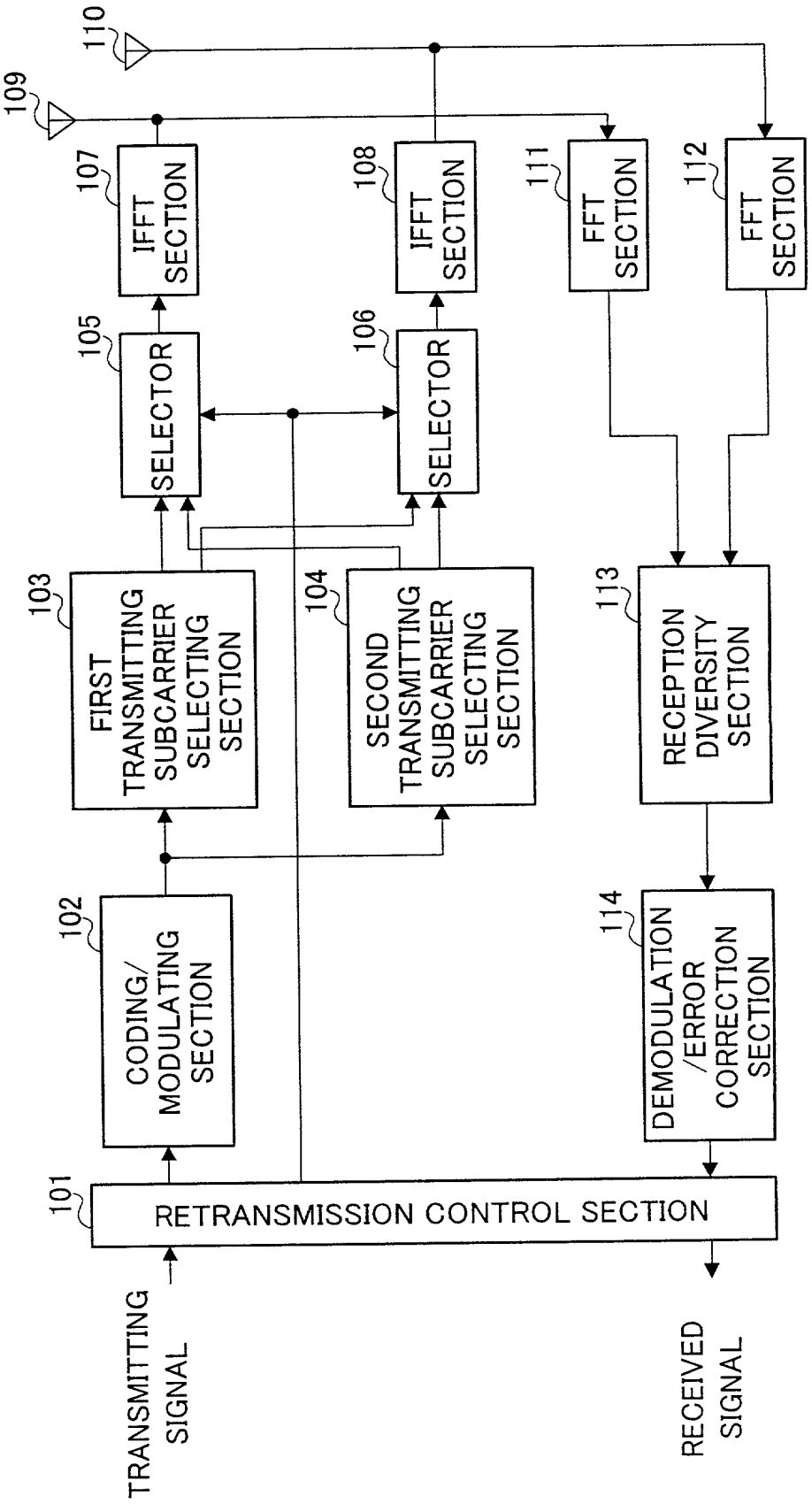


FIG.4


110
109
107
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IFFT SECTION
111
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FFT SECTION
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SELECTOR
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SELECTOR
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FIRST TRANSMITTING SUBCARRIER SELECTING SECTION
104
SECOND TRANSMITTING SUBCARRIER SELECTING SECTION
113
RECEPTION DIVERSITY SECTION
102
CODING/ MODULATING SECTION
114
DEMODULATION /ERROR CORRECTION SECTION
101
RETRANSMISSION CONTROL SECTION
TRANSMITTING SIGNAL
RECEIVED SIGNAL

FIG.5

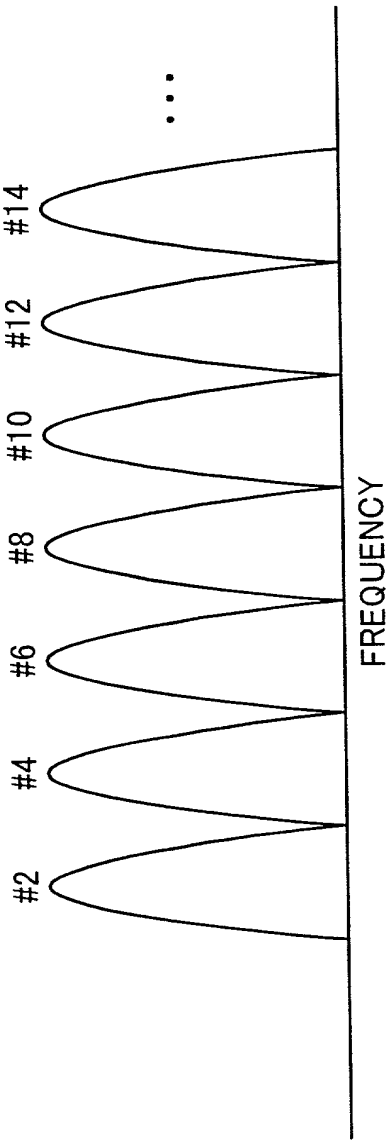

FIG.6 A

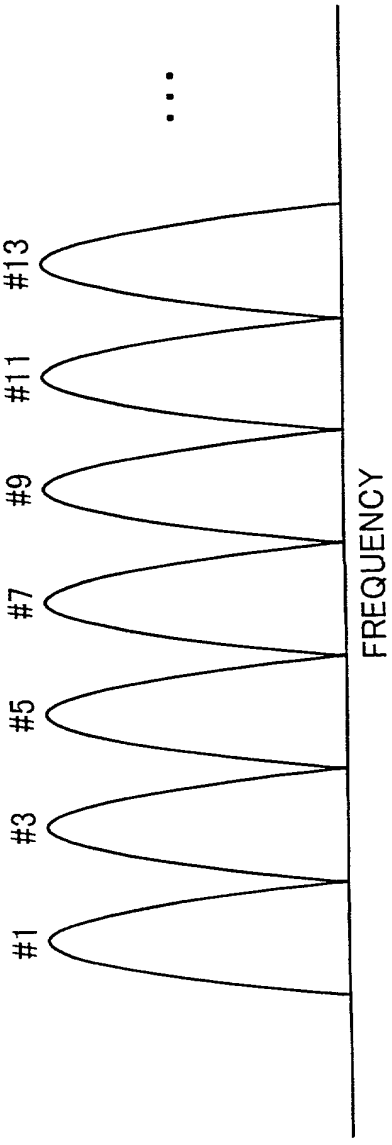

FIG.6 B

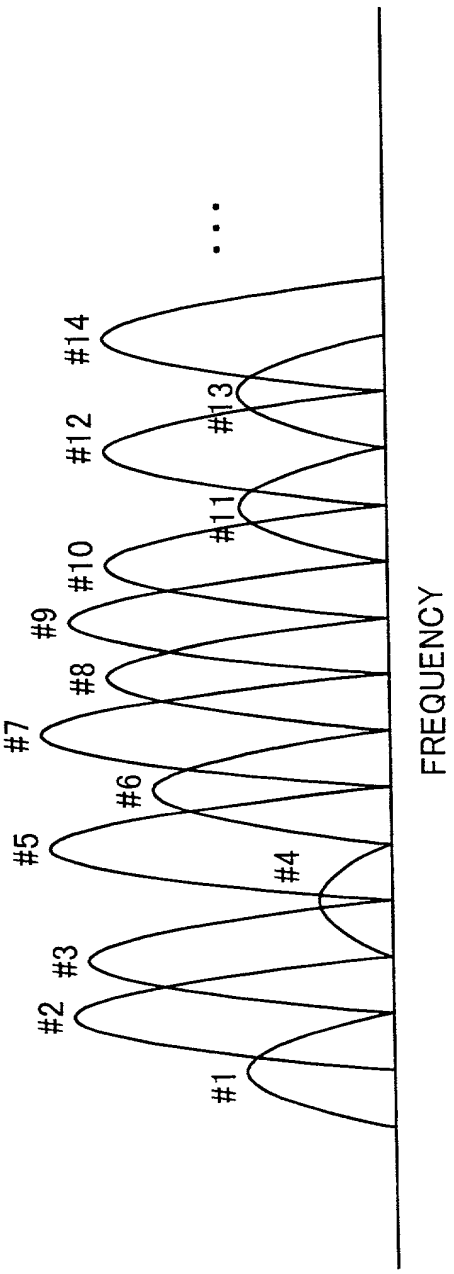

FIG.7

APPLICATION FOR UNITED STATES PATENT
Declaration for Patent Application

As a below named inventor, I hereby declare that:
My residence, post office address and citizenship are as stated below next to my name.
I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on

the invention entitled: OFDM COMMUNICATION APPARATUS

the specification of which 2 (file no _____)

(check at least one)
3 [X] is attached hereto
4 [ ] was filed on _____ as (5) U.S. Application Serial No. _____
6 [ ] and was amended _____ (if applicable)

Use this portion only if you are entering the U.S. National phase based on a PCT International Application designating the U.S.

7 [x] was filed as PCT international application
8 Number **PCT/JP00/05597**
9 on **August 22, 2000**
and was amended under PCT Article(s) 19 and/or 34
10 on _____ (if applicable).

I hereby declare that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended, by any amendment referred to above.
I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me which is material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.
I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application (s) for patent or inventor's certificate listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date earlier than that of the application(s) on which priority is claimed.

Prior (Foreign) Application(s) any Priority Claims Under 35 U.S.C. 119			Priority Claimed	
11a **JAPAN** (Country)	**JP11-240878** (Number)	**27/August/1999** (Day/Month/Year Filed)	[X] Yes	[ ] No
_____ (Country)	_____ (Number)	_____ (Day/Month/Year Filed)	[ ] Yes	[ ] No

[ ] Additional foreign application numbers are listed on a supplemental priority data sheet attached hereto.

Priority Claim(s) from U.S. Provisional Application(s) – I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below:

11b				
Application No.	Day/Month/Year Filed	Application No.	Day/Month/Year Filed

Do not use this portion to identify a PCT application if the parent application is the U.S. National phase of the PCT application

I hereby claim the benefit under Title 35, United States Code, 120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between filing date of the prior application and the national or PCT international filing date of this application.

13			
(U.S. Application Number)	(U.S. Filing Date)	Status (patented, pending, abandoned)

I hereby appoint the following attorneys of the firm of Stevens, Davis, Miller & Mosher, L.L.P. as my attorneys of record with full power of substitution and revocation to prosecute this application and to transact all business in the Patent and Trademark Office:

James E. Ledbetter, Reg. No. 28732; Thomas P. Pavelko, Reg. No. 31689; and Anthony P. Venturino, Reg. No. 31674.

ALL CORRESPONDENCE IN CONNECTION WITH THIS APPLICATION SHOULD BE SENT TO STEVENS, DAVIS, MILLER & MOSHER, L.L.P., 1615 L Street, N.W., Suite 850, Washington, D.C. 20036, TELEPHONE (202) 408-5100, FACSIMILE (202) 408-5200.

See page 2 for signature lines

other side for instructions for completing this form

INSTRUCTIONS FOR COMPLETION OF THIS FORM

line 1 Insert the same title as is used on the specification and in the assignment.

line 2 Is optional but is provided so that you can use it to identify more readily an application prior to the time that the Patent Office application serial number is assigned. We suggest that the specification, drawings and declaration always bear a file number since it can help to get the papers together in case they become inadvertently separated. In instances where the specification is filed without a signed declaration form (under 37 CFR §1.53) a file number on a later-received separate form will assist us in associating it with the correct case.

line 3 Check this box if the specification, claims and drawing (if any) are attached to this declaration form, e.g., when filing a new patent application.

lines 4-5 Are only used in an instance where the application is already on file and the declaration from is being separately filed, e.g.,when the application was originally filed without a signed declaration or where the Patent Office has required a new declaration because of a deficiency in the original declaration. In such an instance the Patent Office will require that lines 4 and 5 be completed with the filing date and application serial number already assigned.

line 6 Is used in conjunction with line 5 but only when there have been one or more amendments to the specification or claims. Line 6 is also used when the Examiner requires a new declaration because claims inserted by amendment cover subject matter not originally claimed (37 CFR §1.67).

lines 7-10 Are for PCT (Patent Cooperation Treaty) cases and are used only when you are entering the U.S. National phase (Chapter I or II) based upon a previously filed PCT International application designating the U.S.

line 7 Check this box if this is a PCT National Phase application.

line 8 Insert PCT International application number.

line 9 Insert date of filing of PCT International application.

lines 10 Insert the date of all amendments filed in the PCT International application. Such amendments are optional, so this line at times will not be used.

line 11a Is used in the following instances:

(i) If a single priority is being claimed from a foreign application you need to list only the first-filed application; you do not need to list other countries if all applications were filed within one year of the U.S. filing.

(ii) If multiple priorities are being claimed, from a plurality of applications filed in one or more countries, you must list the first filed application for each aspect of the invention. Example: if aspect A of the invention was disclosed in an application filed 11 months earlier in country X and aspect B was disclosed 9 months earlier in an application filed in country Y, then the applications in both countries X and Y must be identified. Only the first application for each aspect of the invention needs to be identified provided all applications on that aspect were filed within one year prior to the U.S. filing.

(iii) If a non-priority application is being filed you must list all applications in all countries where corresponding foreign applications were filed more than one year prior to the U.S. filing. This is so the Examiner can check to see if any of those applications were published or patented early enough to be prior art against the U.S. application.

(iv) If there are more than two applications to be listed we suggest that you type in on this form only "See attached Schedule A" and then list all of the previous applications on an attached sheet.

line 11b Is used to claim priority under 35 USC §119(e) based on a provisional application filed within one year of the filing of the instant application. More than one provisional application may be identified provided neither was filed more than one year earlier.

line 12 This block is used only in instances where there is a previously filed U.S. non-provisional application which was copending at the time the present application was (or is being) filed. that previous application could be a U.S. non-provisional application or the National Phase of a PCT allocation. In such a case the present application may be entitled to the priority of the previous application's U.S. filing date (and consequently the foreign priority thereof) provided the present application is identified as a continuing application (continuation, divisional or continuation-in-part) of the earlier (parent) application. If the foregoing is applicable, please fill in one line for each such prior application.

line 13 Type the inventor's proper legal name in the order specified, e.g., "John B. JONES" or "J. Bob JONES" if the inventor so prefers. It is not acceptable to use only initials such as "J. B. JONES."

line 14 The inventor's "signature" may be his (or her) usual manner of signing but it is preferable that the inventor simply write his (or her) name in his (or her) own cursive handwriting in the same order as on line 14, e.g., given name, middle initial and Family name.

line 15 Insert the actual date of signature.

line 16 Insert simply the city and state or country, e.g., "Paris, France", of the inventor's residence, not citizenship. No street address or postal code is required on this line.

line 17 Insert the inventor's citizenship. The statement of citizenship (or subject of) is a statutory requirement (35 USC §115). Simply the name of the country of citizenship, e.g., "Japan" is sufficient.

line 18 Insert the inventor's mailing address. The purpose of requiring the post office address is to enable the Patent Office to communicate directly with the inventor if desired, such as in the case of death of the U.S. attorney. It should be the address where the inventor customarily receives his (or her) mail and should include the postal code. If applicable it can be the inventor's business address or address at place of employment.

Applicants are reminded that the U.S. Patent and Trademark Office has very strict requirements as to proper execution of an application. The applicant should make sure that he reviews the declaration, prior to signing to make sure the declaration properly identifies the application and all relevant information; and should review the specification and claims (including drawings, if any) before signing the declaration. Failure to do so will require the filing of a supplemental declaration --- 37 CFR §1.67(c)

Any handwritten changes to the specification, claims or drawings must be in ink personally by all of the inventors prior to signing the declaration and the adjacent left margin must be initialed and dated by all of the inventors, e.g., "JBJ 6-9-91".

Please let us know if there are any questions regarding proper completion of this form. Thank you.

An assignment, a separate document requiring separate signature and dating may be enclosed. Please look for it and sign and date it in the same manner as in lines 15 and 16 above.

STEVENS, DAVIS, MILLER & MOSHER, L.L.P.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful statements may jeopardize the validity of the application or any patent issuing thereon.

PAGE 2 OF U.S.A. DECLARATION FORM

13a	Typewritten Full Name of Sole or First Inventor	**Hiroaki**		**SUDO**
		Given Name	Middle Name	Family Name
14a	Inventor's Signature	Hiroaki		Sudo
15a	Date of Signature	February	19,	2001
		Month	Day	Year
16a	Residence	**Yokohama-shi**	**Kanagawa**	**JAPAN**
		City	State or Province	Country
17a	Citizenship	**JAPAN**		
18a	Post Office Address *(Insert complete mailing address, including country)*	**508, Saedo-cho, Tsuzuki-ku,**		
		Yokohama-shi, Kanagawa 224-0054 JAPAN		
13b	Typewritten Full Name of Sole or First Inventor			
		Given Name	Middle Name	Family Name
14b	Inventor's Signature			
15b	Date of Signature			
		Month	Day	Year
16b	Residence			
		City	State or Province	Country
17b	Citizenship			
18b	Post Office Address *(Insert complete mailing address, including country)*			
13c	Typewritten Full Name of Sole or First Inventor			
		Given Name	Middle Name	Family Name
14c	Inventor's Signature			
15c	Date of Signature			
		Month	Day	Year
16c	Residence			
		City	State or Province	Country
17c	Citizenship			
18c	Post Office Address *(Insert complete mailing address, including country)*			
13d	Typewritten Full Name of Sole or First Inventor			
		Given Name	Middle Name	Family Name
14d	Inventor's Signature			
15d	Date of Signature			
		Month	Day	Year
16d	Residence			
		City	State or Province	Country
17d	Citizenship			
18d	Post Office Address *(Insert complete mailing address, including country)*			

*Note to Inventor: Please sign name on line 15 exactly as it appears in line 14 and insert the actual date of signing on line 16. If there are more than four inventors, please add a copy of this page for identification and signatures for the additional inventors.